FRD Activities Report
May 2001

Research Programs

CBLAST-Low

The LongEZ research aircraft and its suite of *in situ* and remote sensors are being prepared for the upcoming Coupled Boundary Layer Air-Sea Transfer (CBLAST-Low) light-wind research pilot study which will be conducted in Martha's Vineyard, Massachusetts, from July 20 to August 10, 2001. Listed below are brief summaries of the progress made over the last month on hardware and software modifications. A full project description is available at http://www.noaa.inel.gov/projects/cblast/

Sea Surface Temperature (SST) Sensors

Drifts in sea surface temperature (SST) data acquired by an Everest 4000.4GXL infrared temperature sensor have been linked to changes in the body temperature of the instrument. This was first suspected during the Shoaling Waves Experiment (SHOWEX) when ambient air temperatures (thus sensor body temperature) were near freezing in the morning at the start of a flight and up to 20 °C by late morning to early afternoon when the LongEZ completed its mission.

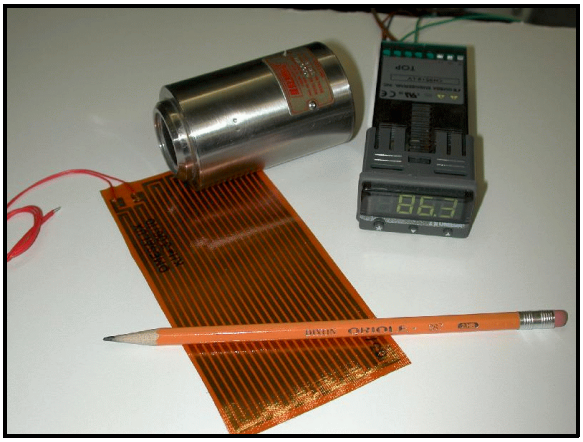

Figure 1. Everest infrared temperature sensor with a Kapton insulated flexible heater and and PID temperature process controller.

Rather than discard this sensor, it was decided that this instrument would be useful if the body temperature of the probe could be kept at a constant temperature. To that end, a PID temperature process controller and a Kapton insulated flexible heater were purchased (Figure 1). The flexible heater was wrapped around the body of the Everest infrared sensor and encased with a layer of insulation. After numerous tests of the sensor against a well-mixed water bath, the temperature controller was set to 30° C.

During the first 60 to 90 minutes, the signal output from the Everest sensor was out of calibration (Figure 2). This was due to temperature gradients being set up within the body of the sensor with the outside being significantly warmer than the inside. However, after this initial "warm-up time", the body temperature was in equilibrium and the results were rather impressive.

The scatter plot shown in Figure 3 represents two tests in which a well mixed bath was heated from near freezing up to 40° C. Note that in both cases, the body temperature of the Everest

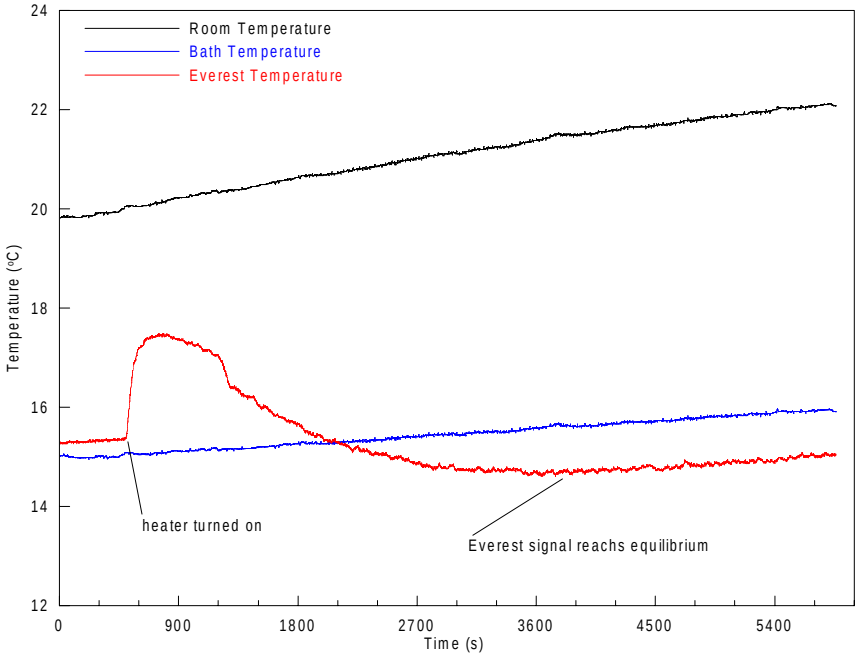

Figure 2. Time series of room, bath, and Everest temperature.

sensor had reached an equilibrium temperature of 30° C. In both tests, these data fall on the same curve. Also note that a temperature "jump" is observed near 25° C. It is thought that the Everest sensor uses different algorithms to compute an output temperature over different temperature ranges. For CBLAST-Low, the temperature range of interest falls between 15° and 20° C. These values are expected for the summertime waters south of Martha's Vineyard with near-shore coastal waters ranging up to about 22° to 24° C. A linear regression for both tests over the range of 15° to 25° C. Both regressions are nearly identical, thus suggesting that the calibration will be stable as long as the body temperature remains constant. In addition, the standard error of fit about these linear regressions is at most 0.07 °C. From these results, we are optimistic that the Everest sensor will acquire reliable estimates of sea surface temperature during the CBLAST-Low pilot experiment. (Jerry.Crescenti@noaa.gov, Randy Johnson, Shane Beard)

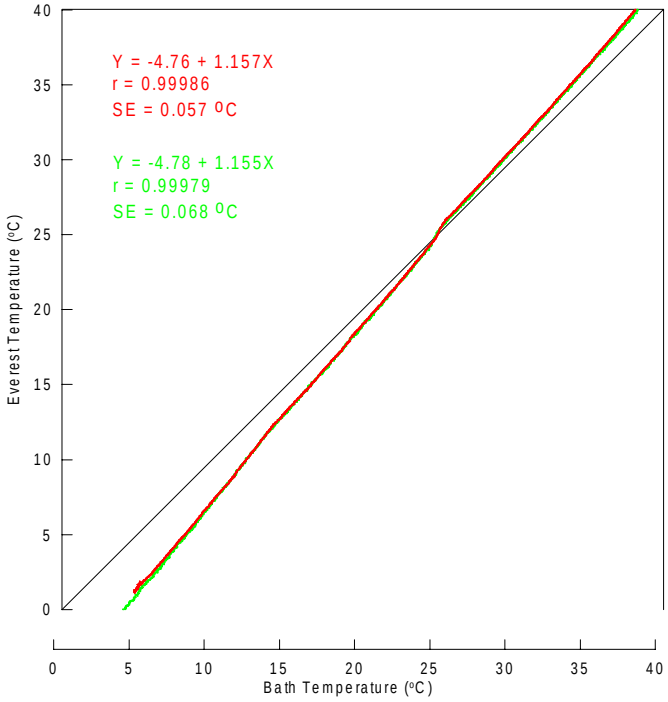

Figure 3. Scatter plot of Everest temperature as a function of bath water temperature. Note that linear regression statistics are for bath temperature range between 15° and 25° C.

<u>Laser Array</u>

FRD is testing a Riegl LD90-450 slow response laser altimeter as a supplemental reference instrument for the autopilot system on the LongEZ. Currently, a pressure transducer controls the autopilot system. However, small changes in barometric pressure over long flux legs can cause the LongEZ to slowly increase or decrease its altitude with respect to the Earth's surface. This may introduce biases in mean and turbulent flux data, especially

in stable boundary layers where strong gradients in the surface layer are commonly observed. The laser, on the other hand, is completely independent of these pressure effects. Early testing of this lazer over a tub of water indicates that this laser will work over the ocean, even under very smooth conditions where the fast response laser altimeters have had frequent problems with measuring altitude.

Scatterometers

Along-track changes in the integrated roughness of short ocean waves on the order of 2 to 100 cm are defined using a nadir-pointing 36-GHz Ka-band (0.8 cm) and 96-GHz Ku-band (2.3 cm) scatterometers. By relating backscatter intensity to the surface slope variance at the two frequencies, short wave characteristics are observed. Coincident laser altimeter measurements provide the precise range information for computation of the normalized radar cross section.

Figure 4. Eric Egan installing the Ku-band microstrip patch antenna under the LongEZ.

The Ku-band scatterometer is a new addition to the LongEZ instrument suite and has been specifically designed for CBLAST-Low. Figure 4 shows Eric Egan installing the nadir-viewing Ku-band micro-patch antenna and faring under the fuselage of the LongEZ. At the LongEZ's deliberately slow 50 ms^{-1} flight speed, the fuselage attitude is approximately 2.5° above horizontal. To maintain the micro-patch antenna nadir, the faring being installed orients the patch at -2.5°. (Jerry.Crescenti@noaa.gov and Tim Crawford)

FUST Probe

Fast response, high-sensitivity temperature measurements from airborne platforms are essential in many atmospheric research applications. The current BAT Probe micro-bead thermistors responds only to temperature fluctuations below 7 Hz. Last July, we began working on the development of the Fast, Ultra Sensitive Temperature (FUST) Probe as part of our high-altitude refractive turbulence

Figue 5. Jeff French installing the FUST element onto the underside of the BAT probe.

research (Figure 5). After testing several designs (see the July 2000 and November 2000 reports) we concluded a 50-μm thermocouple exposed sensing element would meet our design goal of 100 Hz response with 0.01˚C measurement resolution. This is goal is critical to the success of CBLAST-Low. Under very stable atmospheric conditions, the sensible heat flux is very weak. This new responsive probe will be able to quantify those weak turbulent signals occurring at short wavelengths in stable marine atmospheric boundary layers.

This month we completed integration of the FUST element into the BAT probe. The new FUST probe replaces the redundant micro-bead temperature sensor. Because we are concerned the FUST fine wire will not be as robust as the micro-bead, the design allows easy replacement of the sensing element. The fast micro bead in the design stagnation port is also retained for further redundancy. (Jeff.French@noaa.gov, Tim Crawford, Randy Johnson, Jerry Crescenti, and Dave Auble)

Hurricane Balloon

The Smart Balloon (http://www.noaa.inel.gov/capabilities/smartballoon/) is being readied for deployment under the USWRP-Hurricane landfall experiment this year. Critical to deployment is the satellite communications link. We have received a Qualcomm Globalstar 1620 satellite data modem and have permission and an account on the Qualcomm test gateway in San Diego, California. Since this gateway is for testing purposes, we have experienced extended periods of the gateway being out of service for other tests and upgrades but we have been able to originate a data call between the satellite modem and one of our systems connected to a regular modem here in our offices. Thus far, the Globalstar system does not allow the satellite data modem to receive a data call. All data calls must originate with the satellite modem. To minimize the smart balloon software and complexity, our original plans were to have the satellite modem operate in an automatic answer mode and have the ground based data gathering systems originate the calls to the smart balloons. Changes will be made to the smart balloon software and we do not believe this will be a problem if the situation does not change prior to our first launch.

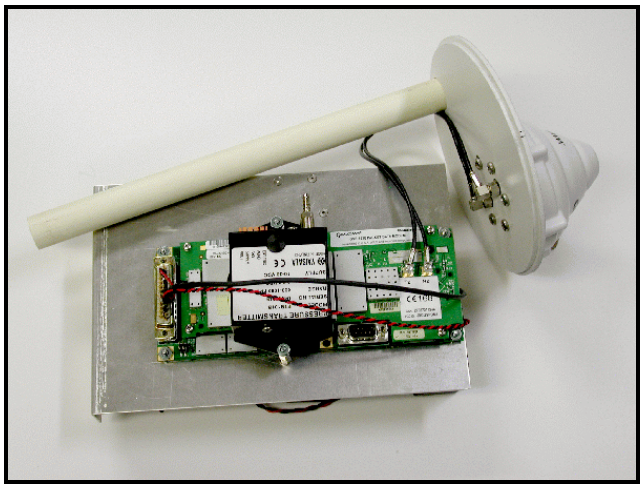

Figure 6. Globalstar satellite modem electronics and antenna.

The Qualcomm 1620 satellite data modem compared to the 1600 satellite phone is lower in cost, consumes less space, and is better suited for integration into an electronics package such as the smart balloon transponder. It provides multiple ports for control and diagnostic purposes while we are developing and testing the system. The antenna for the satellite modem is cone shaped and is placed on the top of the transponder enclosure tube just next to the helium fill tube with 12-inch

cables for both the transmit and receive connectors of the antenna. The smaller volume required to fit the new satellite modem allows placement of the barometric pressure transducer above it as shown in the figure. (Randy.Johnson@noaa.gov, Roger Carter, Shane Beard, Eric Egan)

VTMX/URBAN

The final gas chromatography analysis report for the VTMX study was completed. Included in the report was a thorough quality control/quality assurance discussion of all laboratory blanks, duplicates and controls as well as all field blanks, duplicates and controls. All quality control data indicated there were no significant contamination problems associated with the field or analytical methods. Precision of both the field and analytical methods was very good while bias was minimal and at levels expected for the sampling, handling and storage of samples. Field duplicates however, indicated some discrepancies especially at higher concentrations. A study will be conducted to pinpoint the cause of the discrepancies, which may have been due to turbulence in the downtown areas that were closer to the release site. (Debbie.Lacroix@noaa.gov)

SF_6 tracer data from the Programmable Integrated Bag Samplers (PIGS) and the real-time mobile SF_6 analyzers were distributed to the project sponsors and cooperators. This is a major milestone in completion of the project. (Kirk.Clawson@noaa.gov and staff)

Tracer Gas Technology

We are taking advantage of a break between field projects to investigate ways to improve our atmospheric tracer technology. For the real time SF_6 analyzers, we are testing ways to reduce the audible pump noise which is a significant source of operator stress. We are also looking at improvements in the cleaning procedure, better power connectors, and hopefully ways to reduce the electrical noise in the output signal. A new version of the Automated Tracer Gas Analysis System (ATGAS) has been built and software is being developed for it (Figure 7). The new system is about 70 per cent smaller than the old system and should be about 30 per cent faster. Hopefully testing will begin in the next couple of months. We are also looking at possibilities for new type of analyzers for commonly used atmospheric tracers. (Roger.Carter@noaa.gov, Debbie Lacroix, Shane Beard)

Figure 7. Prototype of new ATGAS system.

Model Validation Program (MVP)

Processing of the Long-EZ data from MVP Session 4 is moving into its final stages. The synchronization problems that plagued this data set have been fixed as much as possible. Additional data-quality flags have been added to the processed data to indicate periods when the synchronization problems may have affected the data in a way that cannot be corrected. Tests are now underway to determine the best frequencies for blending the GPS attitude angles and velocities with the high-frequency accelerometer data. In past experiments, blending frequencies near 1 Hz have typically been used. Preliminary results from Session 4 indicate that frequencies down near 0.1-0.5 Hz may be more suitable. Processing of the Session 4 data is expected to be completed in June or July. (Richard.Eckman@noaa.gov)

Cooperative Research with INEEL

INEEL Mesoscale Meteorological Network

The semi-annual inspections of meteorological instruments on the network towers were completed this month. During the inspections, all instruments are examined to verify they are operating properly, calibrated to traceable NIST standards, and the data collected is accurate and complete. (Tom.Strong@noaa.gov)

The data collection system for the INEEL Mesoscale Meteorological Network received some long needed attention this month. A number of minor software updates were completed and several information files were updated to reflect recent changes. Data for the year 2000 was archived to CD for long term storage. An ailing floppy disk drive was also replaced in one of the server computers. We are also doing testing on radio links through the station located on the top of Big Southern Butte. This station was installed last fall and will be used as a back up radio repeater to keep the system operational when the primary repeater fails. The link testing is needed to determine the network topology that will used when the Big Southern station is brought on line. (Roger.Carter@noaa.gov)

INELVIZ Training

A training course for INELVIZ users was on held May 15. This course on the use and operation of the INELVIZ system is conducted periodically for new users and current users who would like a refresher course. Brad Reese discussed the use and operation of the system, Roger Carter talked about potential problems and how to deal with them, and Jerry Sagendorf presented a description of the model and how it works. (Brad.Reese@noaa.gov, Roger Carter)

Meteorological Monitoring Station

Work on the portable meteorological monitoring station for the INEEL Emergency Operations Bus was completed by May 23. The bus was used during the regularly scheduled emergency response drill on May 31 simulating terrorist activity at the PBF. The weather station system performed well during the exercise. (Randy Johnson@noaa.gov, Tom Strong).

INEEL Emergency Operations Center (EOC) Support

A surprise "no-schedule" drill was conducted on May 15 to simulate a 2500-acre range fire near the Naval Research Facility (NRF) on the Idaho National Engineering and Environmental Laboratory (INEEL). NOAA personnel quickly responded to this notification and provided meteorological support to the INEEL planning bridge. (Jerry.Crescenti@noaa.gov, Brad Reese)

A regularly scheduled emergency response drill was conducted on May 31. The scenario was a simulated terrorist infiltration of the Power Burst Facility (PBF). NOAA personnel participated in the drill and provided meteorological data and short term forecasts to the planning team. (Neil.Hukari@noaa.gov, Roger Carter)

INEEL Meteorological Support

FRD fielded several INEEL requests for meteorological information in May. One request was to provide mean wind speeds for each of the Pasquill-Gifford stability classes. These means will apparently be used as part of the environmental impact modeling for a new facility at INEEL. The means were computed using calendar year 2000 data from the Mesonet tower located at the INEEL Central Facilities Area. Another request was related to the ground-level concentrations expected during a fumigation episode. INEEL also wanted an updated list of the locations and heights of the on-site Mesonet towers for use in constructing a map of potential hazards for low-flying aircraft. (Richard.Eckman@noaa.gov)

INEEL Mesoscale Modeling

The mesoscale modeling at FRD went through a somewhat rocky period during the early spring, in which a combination of network problems and missing fields in the NCEP Eta model output led to a relatively high number of aborted runs with MM5. By mid May, these problems had been worked out, and the MM5 forecasts for Southeast Idaho were again being consistently produced on a daily basis. The forecasts proved to be particularly useful during some high-wind events in the middle of May. MM5 was predicting higher winds over INEEL than over the eastern side of the Snake River Plain, where the NWS tends to focus its forecasts since that is where most of the people are. The Mesonet winds verified the MM5 forecasts, showing significantly stronger winds at INEEL, including gusts over 20 m/s. (Richard.Eckman@noaa.gov)

Other Activities

ARL Review

Tim Crawford and Jerry Crescenti represented FRD at the Air Resources Laboratory review hosted by the Atmospheric Sciences Modeling Division (ASMD) in Research Triangle Park,

North Carolina on May 9 and 10. Tim Crawford gave a presentation on FRD activities and Jerry Crescenti gave a presentation on air-sea interaction research programs. In addition, Tim and Jerry presented two posters entitled *Applying ARL Technology to Solving Air-Sea Interaction Research Problems* and *Tracer Gas Technology: Providing Ground Truth for Dispersion and Air Quality Monitoring*. An emphasis was placed both on the oral presentations and posters on how FRD activities are intimately involved with the four ARL research themes: weather and air quality, coastal, climate, and technology development and transfer. Several pieces of technology were also presented to the peer review panel and NOAA/OAR management (Figure 8). (Tim.Crawford@noaa.gov, Jerry Crescenti, and staff)

Figure 8. Jerry Crescenti explaining the theory of operation of the BAT and ET probes to OAR Deputy Assistant Administrator Louisa Koch during the ARL review.

Educational Outreach

Jerry Crescenti participated in a with the Spectrum classes of Sunnyside Elementary School in a field trip on May 21 to the Idaho Museum of Natural History located on the campus of Idaho State University in Pocatello. Crescenti, who has an undergraduate degree in Earth Science and a Master's degree in Meteorology, was able to answer many questions asked by the students on topics such as geology, oceanography, astronomy, and of course, meteorology. (Jerry.Crescenti@noaa.gov)

Papers

Vickers, D., L. Mahrt, J. Sun, and T. Crawford, 2001: Structure of offshore flow. *Monthly Weather Review*, **129**, 1251-1258.

Travel

May 6-8, Jerry Crescenti to Woods Hole, Massachusetts to attend the CBLAST-Low planning meeting hosted by the Woods Hole Oceanographic Institution.

May 8-11, Tim Crawford and Jerry Crescenti to Raleigh, North Carolina to participate in Air Resources Laboratory Review.

Visitors

May 3, 2001, Michael Welch from the Applied Physics Laboratory at the University of Washington, visited Tim Crawford at FRD to discuss power, size and weight requirements of a system proposed for mounting on the LongEZ.

Awards

Kirk Clawson, as a member of the Aircraft Vortex Spacing System (AVOSS) team, received the 2001 NASA Administrator's Award for Turning Goals in Reality (TGIR). The award was presented at the NASA TGIR conference in Washington, DC, May 16, 2001.